

STEPS TOWARDS A HUMAN WELL BEING FRAMEWORK

INFORMING THE PUGET SOUND PARTNERSHIP AND ACTION AGENDA



Prepared for Puget Sound Partnership

by

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Introduction to the Topic Forum Discussion Papers

As part of the development of the 2020 Action Agenda, six topic forum discussion papers were prepared to provoke and inspire enduring community conversation and critical thinking about the specific problems facing Puget Sound, and the strategies and actions needed to overcome the threats we face. The information from the topic forums was used to help answer two of the four questions of the Action Agenda: a) What is the status of Puget Sound's health and what are the biggest threats to it?; and b) What actions should be taken that will move us from where we are today to a healthy Puget Sound by 2020?

The papers represent the first effort in the region to comprehensively synthesize and document what we know about the Sound's problems, solutions that work, our current approach to solving problems, and what approaches we need to continue, add, or change. These papers address broad science and policy questions, providing an overview of each topic that looks at the Puget Sound ecosystem, from the crest of the Cascades to the Strait of Juan de Fuca, and documenting the basis of our conclusions and recommendations. They were fundamental to establishing strong connections between science and policy as we developed the 2020 Action Agenda.

For five of the topics (human health, land use and habitat, species and biodiversity, water quality, and freshwater quantity), the Partnership commissioned small groups of science and policy experts to prepare a draft discussion paper as a starting point. The papers are organized to logically step through three initial questions (two are science and one is policy) that build to a rational conclusion (the fourth question) about the strategies and actions that we will need to continue, add, or change as a region. The design is intentional so that 1) our policies are based on science and 2) scientists and policy experts talk to one another. The intent of papers is to focus on identifying problems and solutions, rather than specific details about implementation.

The authors were instructed to review available information and prepare a brief overview of the key issues pertaining to each topic. The draft papers were produced in March 2008, reviewed by a broad audience, and discussed at individual topic forums held in April and May 2008. More than 500 people attended the topic forums, and dozens more provided comments online. During the review period, more than 1,200 pages of public comment were received from 229 people or entities. The Partnership, in conjunction with the papers' authors, reviewed and considered all of the comments as we prepared these revised discussion papers. Summarized comments and responses are included as appendices to the papers.

Following this public process, the Partnership Science Panel conducted a peer review of the five papers focused only on the science questions. The peer review addressed: 1) Do the conclusions in the paper have strong analytical support, and what is the nature of that support (e.g., multiple lines of evidence are offered; empirical data, analyses, or model results are available; documentation of rationale underpinning key points is clear)?, 2) What are key uncertainties or gaps in understanding, and how might these be addressed in future work?, and 3) Given reviewer assessment and characterization of the certainty in the paper's content, what guidance can be offered for how this information can be fruitfully used as part of the scientific basis of the

Partnership's work? The general conclusion of the Science Panel and reviewers was that the topic forum papers were a good start at synthesizing information, particularly given the time available and length of the papers. In general, future improvements could include: more thorough discussion and inclusion of some topics (particularly climate change); inclusion of more recent and pertinent peer-reviewed literature and less use of gray literature; consistency and clarification of terms; and more treatment of terrestrial ecosystems. The schedule for developing the Action Agenda in late 2008 did not allow time for revisions to topic form papers following peer review. However, the peer review summaries were evaluated by Partnership staff when considering what portions of the topic forum papers to incorporate into the Action Agenda. The Science Panel concluded that the topic forum process was useful and a version of the process should be conducted in the future.

A sixth paper on human well-being/quality of life was also prepared as a complement to the other five. This interdisciplinary topic is a very new area of work for the Puget Sound region. The paper presents a summary of the human dimensions and quality of life considerations associated with Puget Sound ecosystem recovery as articulated by the Partnership's work products developed in support of completing the 2008 Action Agenda. The human well-being paper also provides an initial human dimensions framework for moving forward.

The discussion papers are intended to be both comprehensive and brief, providing a synthesis of existing, readily available information and an initial list of recommendations for moving forward to achieve the Partnership's six main goals. Work to refine topic forum papers and to integrate the products from the respective topic forums within an ecosystem management framework will be an ongoing effort of the Partnership. In reading the discussion papers, several concepts should be considered:

- **The discussion papers provide an overview of the topic**, summarizing and synthesizing existing documentation. These papers are intended to provide a framework for future management strategies, but are not intended to address in detail all available data on the topic.
- **The Partnership identifies priority actions that are based on science.** People concerned with the future of the Puget Sound ecosystem express a wide range of opinion about the Sound's problems and suggest literally hundreds of ideas for how to solve them. This was evidenced by the broad range of opinions expressed during the topic forum process. Our continuing goal is to find reasonable consensus on the general nature and magnitude of the documented threats to Puget Sound, so that we have a better chance of prioritizing durable and effective solutions.
- **The papers mainly focus on the Sound as a whole.** We know that there are variations in information availability, type and extent of threats, and workable solutions in different parts of our region. The action area profiles in the Action Agenda help highlight local issues.
- **The discussion papers were used to develop cross-topic priorities for the Action Agenda.** A number of key themes emerged from the topic forum process and helped define priorities for management strategies and specific actions.

- **The recommendations to the Partnership in the papers represent the conclusion of the authors based on their expertise and comments received. The recommendations were considered by the Partnership, but should not be interpreted as a Partnership endorsement.** This was an intentional design of the topic forum process.
- **The papers intentionally do not focus on the need for more education/outreach, new funding strategies including creative incentives, and a coordinated monitoring and adaptive management program.** The Partnership knows that these three aspects are critical to long-term success and is using other processes to address them. That work is more fully explained in the Action Agenda. By addressing the system-wide needs, we will be able to more effectively focus the education/outreach, funding, and adaptive management and monitoring strategies.

The Partnership greatly appreciates the level of interest and participation that reviewers showed by attending topic forums and providing thorough, thoughtful comments. The comments that we received have greatly expanded and deepened the overall level of discussion, and moved our knowledge forward on these topics. We are committed to continuing this level of engagement.

INTRODUCTION

BACKGROUND

The welfare of the Puget Sound region depends on healthy ecosystems for the provision of tangible goods such as fish, timber, and local food production, as well as the myriad ecosystem services that regulate climate, purify air and water, provide scenic beauty, and mitigate natural hazards. Though it is clear that people throughout the region benefit from functioning natural systems, the broad range of inter-relationships between human well being, including regional economic health, public health, public safety, and quality of life, and ecosystem health is poorly understood. This dearth of data and tools result in recovery actions which rarely account for the complex interactions between humans, their activities, and the resulting direct and indirect effects upon ecosystem health.

As the region's population continues to grow and pressures on the natural environment become more pronounced, it is increasingly important that we improve our understanding of the many ways in which humans in the Puget Sound region benefit from healthy ecosystems, as well as the many ways in which societal actions can directly and indirectly impair or enhance ecosystem health. Implementation of the 2020 Puget Sound Action Agenda provides a unique opportunity to develop standardized approaches to understanding these complex human and ecosystem threat/driver relationships; this evolving knowledge base may nurture consistency in management responses and ongoing refinement of ecosystem recovery priorities.

The relationship between humans and ecosystem health was acknowledged within the Puget Sound Partnership's enabling legislation, "the quality of life is sustained by a healthy Puget Sound." The term, quality of life, was used to describe the human dimensions of an ecosystem management framework. For the purpose of this Paper, we use the term "Human Well Being" (HWB), instead of Quality of Life as it more accurately captures the wide range of human dimensions of ecosystem management.

The 2006 Task Force Partnership provided an expanded vision for a healthy Puget Sound, one that formally linked human well-being to ecosystem health, in its publication entitled Sound Health Sound Vision:

Puget Sound forever will be a thriving natural system, with clean marine and freshwaters, healthy and abundant native species, natural shorelines and places for public enjoyment, and a vibrant economy that prospers in productive harmony with a healthy Sound. The Puget Sound ecosystem is healthy if we achieve the following goals and can measure results.

The 2006 Sound Health Sound Vision publication outlined six overarching ecosystem management goals for human health, human well-being, species diversity, habitat-land use, water quantity, and water quality. Though there are human dimensions to each goal, the Partnership's decision to specify HWB as a stand-alone ecosystem management goal reflected a desire to manage for functioning ecosystems that support not only natural systems but social and cultural well-being and economic vitality as well such that:

1. Aesthetic values, opportunities for recreation, and access for the enjoyment of Puget Sound are continued and preserved.
2. Upland and marine resources are adequate to sustain the treaty rights, as well as the cultural, spiritual, subsistence, ceremonial, medicinal needs, and economic endeavors of the tribal communities of Puget Sound.
3. The Puget Sound ecosystem supports thriving natural resource and marine industry uses such as agriculture, aquaculture, fisheries, forestry, and tourism.
4. The Puget Sound's economic prosperity is supported by and compatible with the protection and restoration of the ecosystem (Sound Health Sound Vision, 2006)

PURPOSE

Defining human well being (HWB) as one of six ecosystem health goals has been a major step forward for the Puget Sound region. Ecosystem management frameworks nationally to date have not adequately addressed the human dimensions of ecosystem health. An absence of modeling tools, institutional challenges, integration between natural and social science fields, as well as the lack of relevant social and economic studies are contributing factors as to why ecosystem management frameworks around the country have not successfully managed for HWB.

The purpose of this paper is to summarize the many activities conducted as part of Puget Sound Partnership Action Agenda development related to HWB. A reference list of HWB information is provided at the conclusion of this report for those readers interested in additional technical detail.

The primary products and initiatives informing Action Agenda development include:

- Action Agenda Topic Forum Papers
- NOAA Human Dimensions Indicators Work Group Literature Review and Conceptual Models
- World Resources Institute/NOAA/The Nature Conservancy Project: Informing Management and Funding Decisions Using Ecosystem Services
- Action Agenda Finance Strategy
- Action Area Profile Development, Workshops, and Input
- Assessing the Magnitude and Potential Impacts of Threats/Drivers to Puget Sound Ecosystems: A Demonstration Using DPSIR Conceptual Models

Please note that this report does not explicitly address human health dimensions of HWB, given that human health was one of six topic forums convened by the Partnership. The individual topic forum papers, including the one prepared for Human Health, provide additional HWB considerations that are illustrated in Chapter 3 of this synthesis paper.

THEMES

Managing for human well being and economic prosperity is a challenging task, one that requires an understanding of how people interact with their environment. In the process of synthesizing the various HWB activities underway as part of the Partnership Action Agenda development, three themes emerged that provide a description of social-economic-ecosystem interactions characteristic to Puget Sound. Collectively, these principles and themes contribute to a human dimensions framework from which the Puget Sound Partnership may develop a long-term ecosystem management strategy. Subsequent sections of this paper build upon these themes and provide additional detail regarding prospective HWB attributes and indicators, funding/finance, and other tools and strategies that are shaping the forthcoming Action Agenda and implementation strategy.

Theme 1. The natural capital of Puget Sound enhances human well being.

The Puget Sound ecosystem is an important foundation block for our market economy, supports a high level of human well being, and represents priceless natural capital. Puget Sound has provided natural capital to several industries since early settlement, including: commercial harvest of crab, fish (predominately salmon) and shellfish (predominately oyster, mussels, clams, and more recently, geoduck) production, forestry, marine transportation, and tourism. Puget Sound region has and can, if well managed, also produce valued services including natural flood and storm protection, water purification from wetlands, places to go hiking, kayaking, wildlife watching, and ethical, spiritual and cultural sustenance from a myriad of species, habitats and special places. For example, an estimated 52,000 people participated in commercial boat based tours during 1999 to view orca whales. The whale watch

industry is estimated to contribute \$18.4 million annually and provide 205 jobs to the counties adjacent to the Puget Sound through both direct and indirect expenditures (Sound Science, 2007). At the same time, the Puget Sound economy in significant part relies on Puget Sound as a sink for its wastes, such as storm water, toxic chemicals, and other pollutants. In general, residents of and visitors to the Puget Sound have prospered from the existence of the Sound's natural capital. A recently released study conducted by Earth Economics (2008) entitled A New View of the Puget Sound: The Economic Value of Nature's Services in the Puget Sound Basin suggests that the Puget Sound Basin provides \$7.4 to \$61.7 billion in benefits to people each year. If the natural capital of the Puget Sound Basin were treated as an economic asset, the asset value would be at least \$243 billion to \$2.1 trillion. While this particular study has not undergone a thorough peer review it does offer some sense of the positive magnitude of benefits that are derived from goods and services provided by Puget Sound and its impact on human well being.

Further developing our framework of understanding, of our intimate relationship and reliance upon Puget Sound ecosystems, will transform the way in which we approach Puget Sound recovery and management. This evolving knowledge can inform resource management policy, program, and project decisions and will also improve public education and outreach efforts across the spectrum of community, business, and other stakeholder sets of interests. Understanding these linkages will be critical for managing trade-offs over time and will inform the identification and evaluation of management recommendations intended to achieve both human well-being and a healthy Puget Sound. Finally, understanding the myriad contributions of ecosystem services to HWB can be used in the design of effective incentive and non-regulatory management approaches.

Theme 2. Humans impact the environment both negatively and positively.

People have served as agents of positive change, or protectors of ecosystem health, within Puget Sound. Examples of this include successful open space acquisition initiatives within the region that provided permanent protection for vast acreage of ecologically rich areas, working resource lands, and other important networks of parks, regional trails, and open spaces. Puget Sound residents, groups, and communities have also provided leadership in recovering and expanding endangered species; in mandating green infrastructure/low impact development approaches to storm water management; promoting compact, walkable communities; and pursuing multi-modal transportation strategies.

At the same time, however, humans have served as agents of negative change to the environment. Dispersed human settlement patterns in the Puget Sound region, land cover change from vegetation to impervious surfaces, transportation corridors, consumption of marine resources, and the management of surface water resources, while providing significant benefits to HWB, also have stressed the health of Puget Sound ecosystems.

The diversity of human perspective, values and opinions governing human actions make it exceedingly difficult to capture the range of trade-offs associated with human actions and their effects upon HWB and ecosystem health. Different people may experience the same set of effects from a given action but have different values and therefore feel differently about an action. Alternatively, different people may experience different effects from an action, whether or not they have the same set of values. A human action intended to achieve one set of individual or societal outcomes typically affects human well-being in a variety of ways across the populace.

Managing for HWB and ecosystem health requires a systematic approach to examining the range of direct and indirect tradeoffs associated with human actions. Humans will always serve as change agents to their environment and the more completely we understand the diverse values guiding human-ecosystem interactions, the more likely we will successfully mitigate the negative impacts from the additional 1.2 million people by 2020 forecast to arrive within the Puget Sound region.

Theme 3. People are powerfully connected to Puget Sound landscapes and resources.

Every landscape contains unique features and qualities that contribute to a regional and local sense of place. Sense of place is generally defined as the meaning attached to a particular setting by a person or group of people (Jorgensen and Stedman 2001). The characteristics of a physical landscape, and the responses generated by the landscape, are integral to the heart of sense of place (Stedman 2003). Senauer (2008) indicates that there is growing evidence that various experiences in nature could be vital to our health, development, and well-being. Senauer provides a brief summary of some of the key evidence to date. Puget Sound offers a spectacular array of aquatic and terrestrial landscapes that are treasured by residents and visitors alike. Yet, there is an incomplete understanding regarding how changes to the natural and built environment affect people's personal connection to their 'place' and their corresponding desire to take action to protect that which they are connected to. Better understanding the diverse sets of values and meanings that people individually and collectively attach to Puget Sound landscapes will assist with development and implementation of targeted educational, participatory, and voluntary resource management strategies.

Individuals and communities across multiple scales (i.e., property, neighborhood, community, region) are needed to participate in the bottom up/top down ecosystem management strategy that will be required to manage for the human dimensions of ecosystem health in Puget Sound. Unfortunately, our current approaches to environmental and ecosystem management do not always build upon the powerful connection that some members of society have for their environment. Though technically challenging, including sense of place considerations into the forefront of environment decisions, rather than treating it as an interesting yet insignificant detail along the way, is a necessary first step to ensuring that diverse sets of stakeholders are systematically accounted for within resource management decision-making processes over time (Eisenhauer et.al, 2000).

At the same time, it is important to recognize that not all residents of Puget Sound place significant value on conserving, maintaining, or restoring functioning natural systems. There are those that place an equal or higher value on the built environment (e.g., shopping malls, transportation corridors, affordable housing developments) over the natural environment. Accordingly, enhancements to Puget Sound environmental policies, programs, management and regulatory regimes will be necessary to manage for the inevitable sets of tradeoffs presented by regional population growth and an ever changing set of values held for the natural and built environments.

ROAD MAP to the Paper

The HWB Synthesis Paper is structured as follows. Chapter 1 summarizes concepts and definitions associated with ecosystem services and valuation theory. Chapter 2 offers a synopsis of the many tools currently being developed to characterize, measure, and model various dimensions of HWB, in conjunction with interdisciplinary ecosystem framework approaches being developed for Puget Sound (e.g., NOAA/NMFS Human Dimensions Group, Puget Sound Nearshore Restoration Program). Chapter 3 profiles human well being management considerations, as part of implementing the Action Agenda. Chapter 4 provides a brief overview of the Partnership's evolving funding and finance strategy for the Action Agenda.. Chapter 5 provides a set of gaps in HWB understanding intended to inform future HWB science agendas, policy, regulatory reform, and project activities over time. A reference list and glossary of terms are provided at the conclusion of this report.

1.1 Introduction—the Importance of Valuing Puget Sound’s Ecosystem Services

The well-being of people in the region depends in many ways on functioning ecosystems and this dependence can be usefully captured through the concept of ‘ecosystem services’¹. Ecosystem services are the variety of benefits that ecosystems (e.g., forests, eelgrass beds, wetlands marshes, or marine shorelines) provide to people, communities, and businesses. Given the inherent challenges associated with monetizing the value of ecosystem services, the values associated with these ecosystem functions are currently under-represented within current institutions and do not always receive consideration, commensurate with goods and services in standard markets. To compensate for losses in ecosystem services, our region has employed a wide range of programmatic, regulatory and designed solutions to provide humans with the services formerly provided for free, by healthy functioning ecosystems. An example of the latter is the potential need for LOTT to construct sewage treatment facilities of greater capacity in order to meet requirement of new NPDES permit imposing decrease in summer critical season pollutant discharge into Bud Inlet (Deschutes Estuary Feasibility Study, 2006).

The following sections of this paper are based on initial work by members of an initial group of stakeholders, convened by the Partnership, which met to discuss quality of life topics and to identify unique regional HWB attributes. In combination with the World Resources Institute, The Nature Conservancy, and NOAA work described later in this chapter, this information will help identify ecosystem services people most care about, but also the fundamental ecosystem services that provide the foundation for the region’s prosperity and HWB.

Understanding how our welfare is related to ecosystem services and the value of those services (both the market and non-market value), will assist in making better decisions about priorities for action, as well as help to identify the most cost-effective actions to take.

1.2. Ecosystem Services and Their Value for People

Everyone who lives in or visits the Puget Sound region depends to some extent on the natural environment—the air we breathe, the water we drink, and the some of the food we eat all come ultimately from the natural environment. People in this region depend not only on Puget Sound ecosystems, but also frequently on the services provided by very distant ecosystems—e.g., salmon that spawn in Alaskan streams or coffee production that may rely on native pollinators in Central America. While our actions also affect distant ecosystems, we have much greater potential to directly affect the condition and provision of ecosystem services in Puget Sound than in more distant areas.

Human well-being and healthy ecosystems are at times closely related to each other—particularly so in a region in which the economy remains in part tied to natural resource industries and in which the natural beauty of the region attracts visitors and new residents alike. The people of this region receive many direct and indirect benefits from functioning ecosystems within the region but we are not always aware of all the benefits we receive, or of how dependent we are on the natural world. Because we are not aware of this dependence, we tend to discount or undervalue the benefits we receive from healthy ecosystems. However, as the region’s population grows and pressures on the natural environment increase, more and more people are beginning to recognize that some attributes of human well-being are dependent on the continued functioning of healthy ecosystems—not just for tangible goods such as fish, timber, or minerals, but for the myriad ecosystem services that regulate climate, purify water, and mitigate natural hazards.

¹ Ecosystem services are also some times referred to as environmental services; the terms natural capital or green infrastructure are also some times used to refer to the benefits people realize from the natural world or the contribute of the environment to HWB.

Most people are familiar with the importance of **goods** that ecosystems provide. These goods have long had economic or market values that are commonly recognized and are readily factored into decisions about resource management. The market or commercial values of fisheries, shellfish harvests, timber, agricultural crops, or sand and gravel mining are easily recognized, and relatively easily valued because markets exist for these goods. However, people depend on healthy ecosystems for much more than these commonly recognized goods. Ecosystem **services** include for example, water purification, flood storage/flood mitigation, soil stabilization/erosion control, waste assimilation, and pollination of crops. These ecosystem services provide for many human needs that are essential for well-being, such as physical health, spiritual and cultural inspiration, mental health and healthy communities, recreation, aesthetic inspiration, sources of creativity and innovation, and basic material well-being in terms of food, shelter, and energy.

Even though these services are essential, because they provide indirect benefits and do not have monetary values in our market systems, their true value to people often goes unrecognized. Because the values are unrecognized, they are very difficult to include in environmental management and decision making. A classic example is forested land with wetlands that provide flood storage and water quality benefits to people living downstream. The value of flood protection and clean drinking water to those people may be significant. Under our current economic system, however, the owner of the land does not receive compensation for these services given that there is no means by which to exclude others from benefiting from them and therefore the forest land owner has no incentive to manage for these services. The lack of market value also makes it difficult for policy makers to evaluate the relative costs and benefits of constructing facilities such as treatment plants to provide clean drinking water versus the costs of providing clean drinking water through protection of forest lands in the watershed. The lack of markets and recognition of ecosystem services to our economic system thus provides strong economic incentives for negatively impacting ecosystem services, but few incentives for protecting or restoring those services.

1.3 The MEA Ecosystem Framework for Describing Ecosystem Services

At the turn of the last century, a collaborative effort among the world's scientists, the Millennium Ecosystem Assessment (MEA), produced the first comprehensive description of the reliance of people on the world's ecosystems (MEA 2005a). The MEA also developed a classification framework for ecosystem services, which is a useful way of capturing the complexity of ecosystem services. Most of the benefits provided to people can be captured in the following four types of services: provisioning, regulating, cultural, and supporting.

Types of Ecosystem Services	Puget Sound Examples
Provisioning: Food from crops and livestock; capture fisheries and hunting, aquaculture, wild foods; fiber such as timber and plants; biomass fuel; water; genetic resources; and medicines, food additives, and other biological materials.	Berries, bulbs and seed crops Dairy and poultry Salmon, crab and clams Cultured oysters, mussels, geoduck and salmon Mushrooms and berries Timber and pulp, seaweed Floral products Firewood Drinking water, hydro-power and waterborne transport Genetic materials from individual populations of species DHA from salmon (a beneficial fatty acid) and carageenan from seaweed (food additive)
Regulating: Air quality, climate, water quantity and quality, disease, pest, pollination, and natural hazard management.	Lakes and water bodies are sinks for effluent Forests and eelgrass capture and store carbon dioxide Forests influence regional rainfall Wetlands and floodplains manage stormwater runoff Forests and buffers control erosion and landslide hazard Eelgrass and shellfish species break down some pollutants Wetlands serve as filtration systems Control of harmful algal blooms, pest species Pollination Buffer the effects of natural disasters (storm, forest fire)
Cultural: Recreation and ecotourism, existence and ethical values, and traditional values and lifestyles.	Hiking, camping, birdwatching, whale watching, boating, fishing, clamming, hunting. Belief that all species are worth protecting Spiritual fulfillment from the direct contact with nature Protection of traditional and religious cultures associated with nature (tribal beliefs, arts and traditions associated with salmon, cedar, and other native species)
Supporting: Role of ecosystems in nutrient cycles, decomposition, photosynthesis and the water cycle.	All of the above services are derived from ecosystem function.

1.4 Puget Sound Ecosystem Services

The forests, wetlands, estuaries, prairies, beaches, bluffs, and marine waters of the Puget Sound region provide a wide range of diverse ecosystem services that benefit people. The greater the recognition of the contribution of the region's ecosystems to HWB, the more environmental management decisions can reflect the HWB values of preserving and restoring particular ecosystems. In addition, knowledge of our dependence on ecosystem services can provide valuable information for evaluating trade-offs that can occur between different attributes of HWB. Some examples of the provisioning, regulating, cultural, and supporting services provided by Puget Sound ecosystems are described below.

Provisioning services provided by Puget Sound environments include fish and shellfish that are subject to cultural use, commercial and recreational harvest; fresh water (for drinking, irrigation, transport); marine waters; forest products (timber, as well as non-timber forest products such as mushrooms, berries); the larvae/eggs of fish and shellfish used in aquaculture and/or hatcheries; and medicines/pharmaceuticals such as taxol².

² Taxol is a compound extracted from yew bark which has been identified as a possible anticancer agent; the National Cancer Institute (NCI) has found taxol to be one of the most promising of more than 120,000 plant compounds tested for anticancer properties. Taxol appears to be effective against a wide range of tumors, and is particularly useful in the treatment of refractory ovarian cancer.

One potentially important provisioning service is the provision of genetic and biomaterials that are reflected in the diversity of species in the region. Genetic resources and biomaterials can contribute to the discovery of new medicines or raw materials that can enhance many industrial processes. The extent to which useful materials and genetic resources from Puget Sound ecosystems might contribute to HWB in the future is unknown. However, research continues to identify natural products that have the potential to provide significant economic and health benefits. For example, recently identified natural substances produced by macroalgae, eelgrass, sponges, and other marine organisms have been found to be powerful antifouling substances—they prevent the settlement of barnacles and other organisms that can foul boats and in-water structures (Fusetani and Clare, 2006). These natural substances can provide environmentally safe and sometimes less expensive ways to protect structures in marine environments than the heavy metals-based paints that have traditionally been used (e.g., tributyltin or TBT).

Regulating services include the capacity of ecosystems to regulate critical biological, physical, and chemical cycles and processes, such as pest and disease control, pollination, runoff/infiltration processes, water purification, carbon sequestration/climate change, soil stabilization/erosion control, microclimate regulation (e.g., temperature and moisture regimes), waste assimilation, buffering from storm and flood damage, and nutrient cycling (Peterson and Lubchenko, 1997; MEA 2005b, Philcox 2007; Ronnback et al., 2007). Many regulating services rely heavily on the presence of natural habitats in the landscape. One example is the contribution that native bees and other insects make to the pollination of crop plants. Farmers pay commercial beekeepers to pollinate their crops, but numerous studies show that the presence of natural habitats and native pollinators next to farms greatly increases the success of pollination and adds to the commercial value of the crops (Kremen et al., 2002). Because honeybees are suffering severe population declines across the United States, the presence of native pollinators will become even more important in the future (Kremen et al., 2004).

Examples of regulating services related to Puget Sound habitats include services provided by shellfish beds: water filtration and purification, waste assimilation, stabilization of substrate and energy dissipation which reduces erosion and protects shorelines, food web support and provision of habitat for other invertebrates and fish (Coen et al., 2007, Grabowski and Peterson 2007). The water filtration services of shellfish can provide partial control of algal blooms and therefore reduce incidents of hypoxia or low oxygen, as well as reduce or avoid incidents of paralytic shellfish poisoning and other seafood contamination and health issues associated with increased frequency of harmful algal blooms in Puget Sound. Water filtration also reduces turbidity (by removing large numbers of plankton from the water column) resulting in benefits to eelgrass and other submerged aquatic vegetation which provide critical feeding, refuge, and breeding habitat for salmonids, forage fish, waterfowl, and marine invertebrates.

Forested watersheds and wetlands contribute numerous regulating services that contribute to HWB, including the following (Guo et al., 2007):

- Regulation of water supplies through enhancing infiltration of rainwater, support of baseflows in streams, and recharge of groundwater
- Water purification through the prevention of erosion and retention of sediment and uptake of nutrients and pollutants
- Air quality regulation from forests through the absorption of gases and pollutants, the filtering of particulate pollutants from the air, and the lowering air temperatures
- Climate regulation/climate change mitigation through the uptake and sequestering of carbon dioxide in forest trees
- Habitat for fish and wildlife species of commercial, recreational, cultural, and or aesthetic value
- Landslide hazard mitigation through the stabilizing effect of forested vegetation on slopes
- Flood hazard mitigation through runoff regulation and moderation of peak flows from forests and the flood water storage provided by wetlands
- Cultural/aesthetic/spiritual values through the enjoyment of natural landscapes, sense of place, and recreational opportunities

Finally, hazard mitigation services are a type of ecosystem services that are provided to some degree by a wide range of Puget Sound ecosystems. Submerged aquatic vegetation such as eelgrass can dampen wave energy during storms and help protect shorelines from erosion. The coastal wetlands associated with estuaries and smaller coastal marshes also absorb storm floods and tidal surges and protect coastal areas from storm and flood damage (Wilson et al., 2005; Pendleton, 2008). Vegetation on steep slopes and coastal bluffs can reduce landslide hazards by holding soil in place and controlling the infiltration and runoff of rainwater. Natural hazard mitigation services are potentially very valuable to residents of the region, both in terms of the reduced economic costs of property damage and in the increased safety and security from injury or loss of life.

Cultural services are related to the aesthetic and recreational opportunities, cultural and artistic inspiration, and spiritual and religious enrichment provided by natural systems (MEA 2005a, Brauman et al., 2007). Puget Sound ecosystems provide a wealth of cultural ecosystem services such as a wide variety of recreational opportunities, cultural identity and livelihood, and aesthetics and artistic inspiration, linked to the inspiring scenery associated with the mountains and Sound, the diversity of landscape or habitat types (prairies, beaches, alpine meadows, forests), and the cultural landscapes of working farms, maritime industries, and fishing communities. The diversity of natural landscapes is related to the cultural diversity that contributes strongly to the character of the region and to the sense of community that is important to HWB.

In addition to these services, the information/educational/research value of the natural environment is important for enhancing our understanding of natural systems, understanding global climate change, and providing indicators of changes in environmental condition or ecosystem health. The study of healthy natural systems contributes greatly to our understanding of how ecosystems provide the services that benefit us, how ecosystems respond to stresses and impacts from human activities, and how our environment is likely to be affected by climate change. This information is vital to our ability to make balanced environmental and social-economic decisions now and in the future.

Finally, the natural landscapes and species of Puget Sound have existence values in and of themselves. Many people appreciate the fact that these species and landscapes exist; this appreciation is strong even among some individuals who may never visit the region and/or see the species themselves (e.g., generally universal appreciation for biological icons like the killer whale or king salmon, both listed under the Endangered Species Act). Many of the less tangible attributes of HWB are closely associated with cultural services. For example, some evidence supports the suggestion that contact with nature and natural landscapes relieves stress, reduces mental fatigue, increases recovery rates from surgery, and increases a person's overall sense of well-being (Ulrich, 1984; Ulrich et al., 1991; Rohde and Kendle, 1997; Stilgoe, 2001).

Supporting services include basic properties or processes of ecosystems that are critical to continued ecosystem function, such as resilience³, photosynthesis/plant productivity, natural cycles of water, nutrients, minerals and other substances necessary to sustain life and biological production, physical processes that create and maintain habitats, and biological diversity (Beaumont et al., 2006; Ronnback et al., 2007). One way of thinking about supporting services relative to the other services would be to define a set of 'fundamental' ecosystem services (Holmlund and Hammer, 1999; Brauman et al., 2007). These fundamental services are a necessary pre-condition for the existence of the other services and support the sustainable flow of those services through the system (see Worm et al., 2006).

³ Resilience is generally defined as the ability of the system to respond to change and/or disturbance while maintaining typical processes, structures, and functions—in other words to weather change without an irreversible change in state.

1.5 Supporting Ecosystem Service-Based policy and Management in Puget Sound

A joint project led by The Nature Conservancy (TNC), NOAA Fisheries' Northwest Fisheries Science Center (NOAA) and the World Resources Institute (WRI) is providing scientific and policy support to advance the work of the PSP and will develop a general approach to using ecosystem services that can be applied to management of human and natural systems around the world. This work is funded by the David and Lucile Packard Foundation.

The central concepts underpinning this project is that identification of important goods and services and tradeoffs that may occur between goods and services, and a discussion of how the information can help (1) refine goals and indicators for a healthy Puget Sound, and (2) prioritize strategies and actions. The two key dimensions of this effort are (1) the science of mapping, modeling, and valuing ecosystem services, and (2) the craft of melding information on ecosystem services with critical public decisions and public/private finance opportunities. The results from this work are intended to help answer these types of questions:

- How does a proposed land use management plan affect timber yields, biodiversity, water quality, and recreation in a watershed?
- Which parts of a watershed provide the greatest carbon sequestration, biodiversity, and tourism values? Where would reforestation or restoring riparian vegetation achieve the greatest downstream water quality benefits?
- How would changes in agricultural practices and locations of farms affect a downstream city's drinking water supply? How will climate change and population growth impact these effects?
- How would changes in nearshore habitat uses—such as aquaculture, shoreline development, or eelgrass restoration—affect shoreline stability, coastal recreational use patterns, or commercial and recreational catches of Dungeness crab, rockfish, and lingcod?

1.5.1 Mapping, Modeling and Valuing Ecosystem Services as a Science Foundation

At the heart of any use of ecosystem services in formulating policy or informing decisions are spatially explicit layers of data regarding multiple ecosystem services. In any given decision or situation it may be that only a few ecosystem services are of initial interest. However, in all cases it will be advantageous to have multiple layers of ecosystem service data and maps—if only to verify assumptions about which services are most important in any given locale and to help identify interactions and trade-offs among services as a result of different policy and management regimes.

Tools for modeling and mapping nearshore and marine-related ecosystem services are not as well developed as those for upland habitats, and are being developed by NOAA Fisheries' Northwest Fisheries Science Center (NOAA). NOAA is starting with models of ecosystem services that are provided by nearshore habitats, such as beaches, sandy, cobble or rocky areas, and kelp and eelgrass beds. These models allow us to estimate how changes in nearshore habitat uses—such as aquaculture, parks, or developed shorelines—are likely to affect services provided by those habitats. Potential tradeoffs in shoreline protection, wildlife viewing, recreational and commercial fishing and clamming, and food web support can be highlighted under different scenarios of future use. Initial results from these models will be available in the fall of 2008, with further refinements and details to be added in 2009.

With further policy input through the PSP and its stakeholders, likely economic consequences of alternative management approaches and their effects on ecosystem services can be provided as ultimate outputs from the terrestrial, freshwater and nearshore marine models described above. Economic consequences of alternative management strategies can be expressed in terms including income from hydropower, irrigation, industrial, and drinking water costs, costs of flood damage, net present value of timber, carbon credits, and crop yields, recreational and commercial catch revenues and flows into local economies, shoreline property values, way of life and biodiversity existence values, and site income from recreation. Which of these services are most interesting to the

PSP for valuation will be informed by the work of the World Resources Institute and such valuations will be available in 2009.

I.5.2. Identifying Important Goods and Services

The second main thrust of this project was led by the World Resources Institute to identify what ecosystem services are most valued by the diverse sectors within the Puget Sound Basin; and how the activities of different sectors both impact and depend on services. The “most important” ecosystem goods and services are those derived from the Puget Sound that the region’s stakeholders most value or that most contribute to stakeholder well-being. This analysis will help more explicitly describe and communicate the most important elements of a ‘healthy’ Puget Sound in terms of thriving natural and human communities. It also will help point priority strategies towards the most valued of our diverse objectives over the long term. This analysis is addressing the following questions:

1. What ecosystem services do individuals and institutions depend on for the attainment of their goals or for their personal well being?
2. What is the current condition and trends of these services?
3. What are key decisions made by individuals or institutions that have the greatest potential impact on ecosystem status? (Potential impact could be described based on immediacy, reversibility, scope, etc.)
4. Who makes those decisions with greatest impact (i.e., what is the sector—business, NGO, Federal, tribal, state, or local government, citizens, etc.?) What risks and opportunities emerge as a result of changes to ecosystem services?
5. How could ES information qualitatively or quantitatively change the decisions that are made by each sector? e.g., How are the transparency and content of their deliberations changed using ecosystem service information? How do ecosystem outcomes (i.e., ES) change under different sets of decisions?

The results of this work are available on the Partnership website.

Chapter 2 Indicators of Human Well Being

2.1 Introduction

One of the key responsibilities of the Partnership will be to assess the health of Puget Sound ecosystem and HWB and communicate this assessment to the public and policy decision makers. To do this the Partnership needs a set of attributes and indicators that can be measured, monitored and effectively communicated. While social and economic indicators have been used extensively in understanding social and economic systems and policy they have been used less frequently in ecosystem management. In order to manage more effectively for HWB in the process of Puget Sound restoration and long-term sustained health, it has become clear that attributes and indicators of HWB must be included and made commensurate with natural system ecosystem attributes and indicators

The NOAA Human Dimensions group (NHDG) has produced a comprehensive document that provides a general understanding of the use and application of social and economic indicators as well as the possible linkages between social and ecological indicators. Through an exhaustive literature review they found that there is no one set of HWB categories on which all researchers agree (Plummer and Schneider 2008.). There is no one set way in which to understand or evaluate human conditions. Additionally, there are numerous indicators which could be used to describe each category and or attribute.

2.2 Conceptual Models of Human Well Being

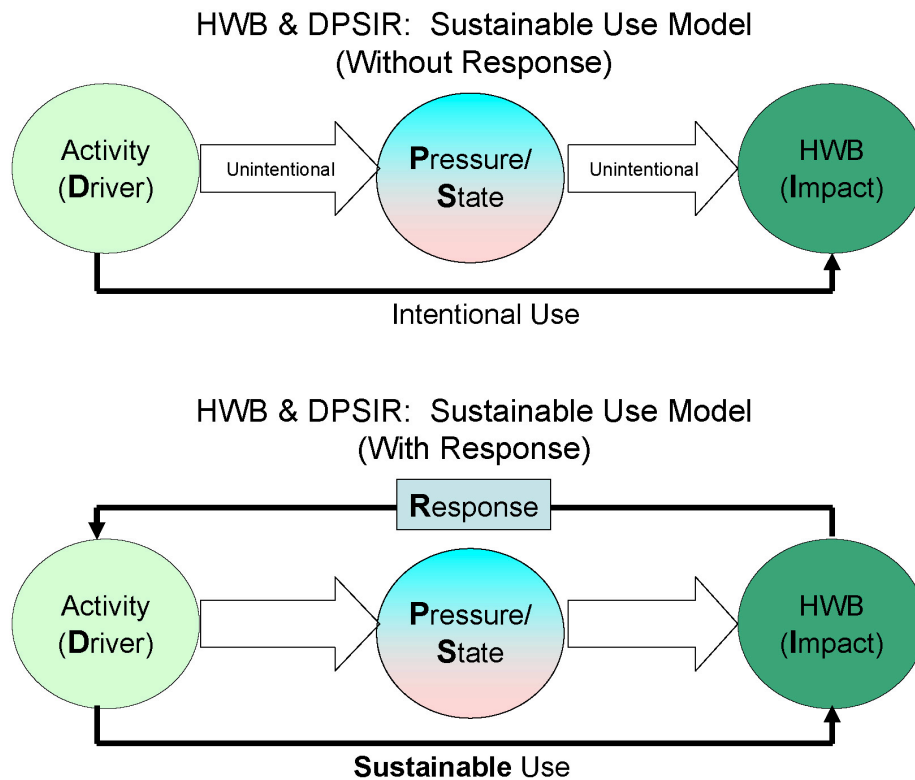
In order to assess the best suite of HWB indicators, The NHDG created conceptual models of human well-being (HWB) adapted from the Driver-Pressure-State-Impact-Response (DPSIR) models being used to illustrate the causal networks of environmental problems in the Puget Sound Region.⁴ The following description of the NHDG two conceptual models for considering HWB is taken from their draft report. The model is for the “sustainable use” of a resource, focusing on a single activity and the HWB derived from that activity. The second conceptual model covers a situation where multiple activities support HWB, but one activity (or more) unintentionally affects the other(s). This model shows how multiple indicators are needed to ensure that the effect of responses on aggregate HWB is tracked.

The sustainable use conceptual model describes a system in which the activity of interest involves the extraction of a natural resource (e.g. fishing, forestry, etc.). In this conceptual model (Figure 1), an activity (*Driver*) that increases HWB can unintentionally affect an ecosystem component (e.g. *Pressure/State* of species, habitat, water quality, etc.). If the level of extraction is greater than the ability of the ecosystem to provide a renewable flow of services, the level is unsustainable and will eventually fall, decreasing HWB. A *Response* takes the form of limiting extraction to a sustainable level: i.e., a level that can be maintained over the long run. In the short run, however, this will actually decrease HWB.

In the aggregate HWB conceptual model (Figure 2), an activity (*Driver*) that is intended to increase HWB can also have unintended consequences that affect ecosystem components (e.g. *Pressure/State* for water quality, habitat, etc.). These unintended consequences can thereby affect other aspects of HWB. A *Response* intended to reduce these unintended consequences can increase HWB by bolstering the *Impact* activity and thus increase the HWB associated with that activity. The *Response* usually achieves this by restricting the *Driver* activity, however, which can decrease HWB. Ideally, the *Response* will achieve a balance that increases aggregate HWB (Figure 3). It is possible, however, that the *Response* can be so strong that the gain in HWB through the *Impact* activity is outweighed by the losses suffered by the *Driver* activity (Figure 4). The effect of the *Response* on aggregate HWB, then, is found by accounting for the elements of HWB connected to the *Impact* activity as well as those and those connected to the *Driver* activity.

⁴ See O'Neill *et al.* (2008) for the use of the DPSIR models for the other ecosystem components.

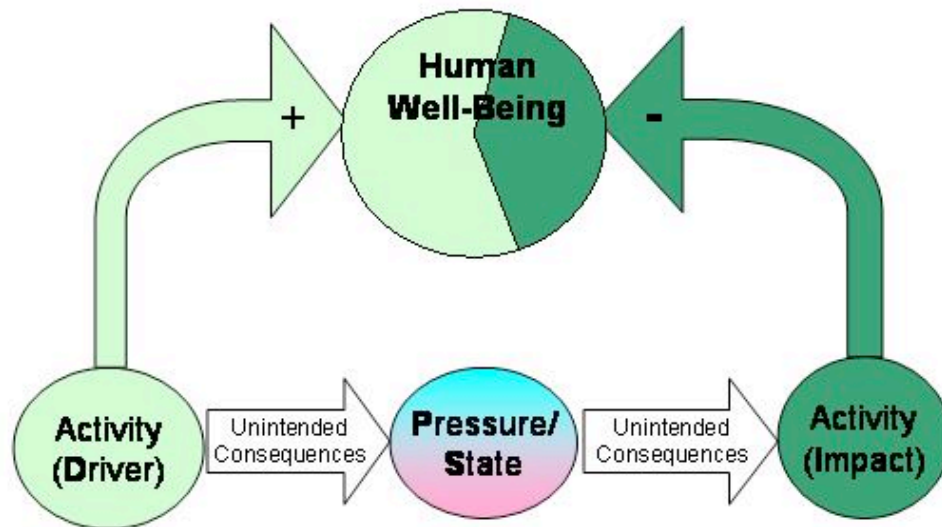
Figure 1: Sustainable Use Conceptual Model. (National Marine Fisheries Service, 2009)



Schneider and Plummer
July 2008

Figure 2: HWB DPSIR Aggregate Conceptual Model. (National Marine Fisheries Service, 2009)

**HWB & DPSIR: Aggregate Model
(without Response)**



Schneider and Plummer
July 2008

Figure 3: Human Well Being Aggregate Conceptual Model with response which increases aggregate (overall) HWB while providing increased ecosystem services and minimally decreased driver activity. (National Marine Fisheries Service, 2009)

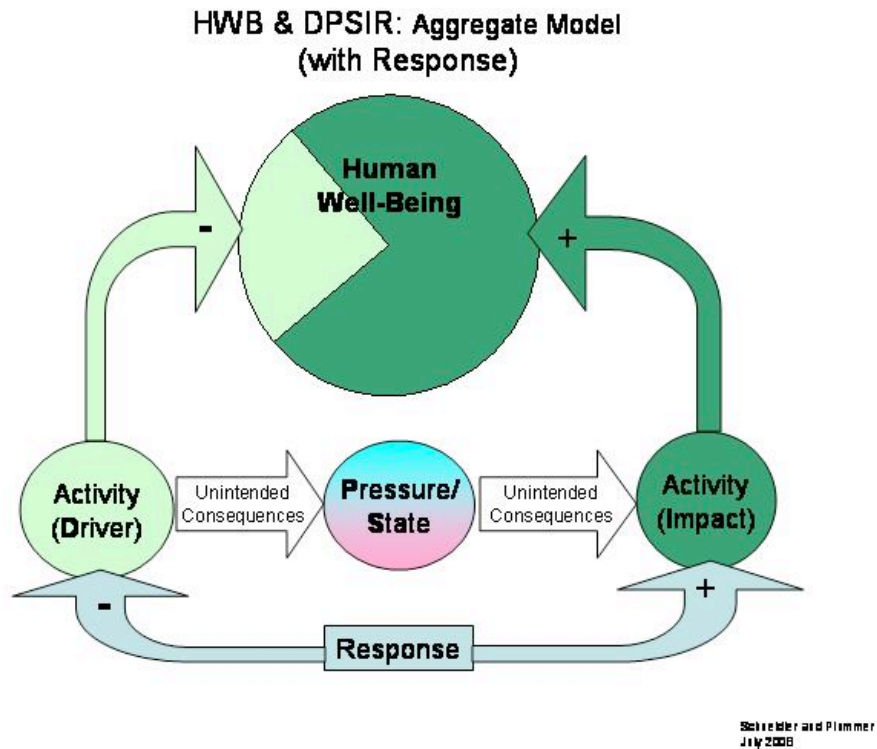
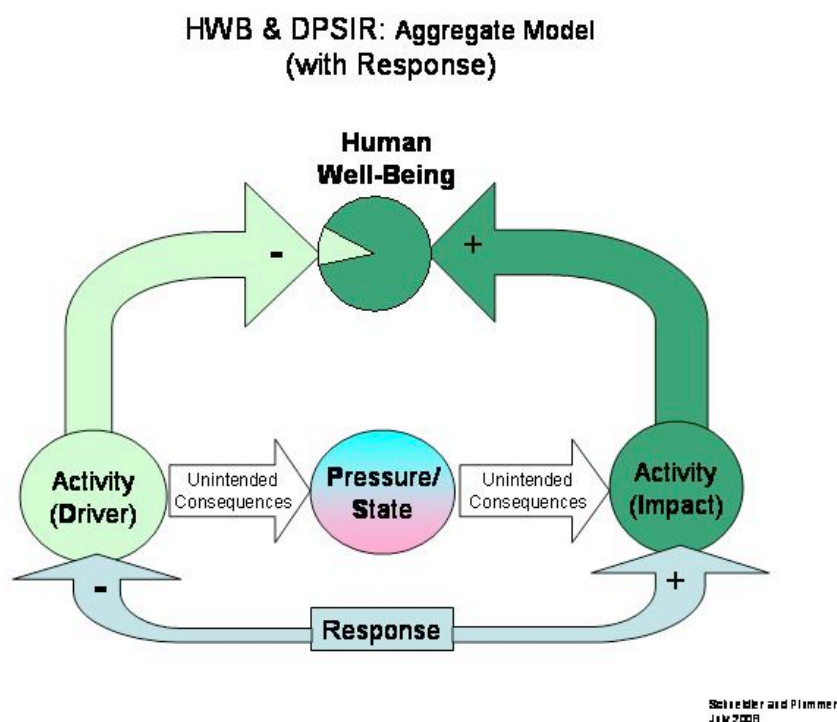


Figure 4: Human Well Being Aggregate Conceptual Model with response which decreases aggregate (overall) HWB despite ecosystem services increase due to severe driver decrease. (National Marine Fisheries Service, 2009)



These conceptual models offer insights into the problem of choosing indicators for HWB in Puget Sound. For the sustainable use model, an indicator such as harvest level accurately reflects changes in HWB that stem from changes in policy (the *Response*), but it only parallels changes in the underlying ecosystem health if harvest is at a sustainable level. If not, an increase in harvest indicates an increase in short run HWB, but may also be the precursor to decreasing HWB in the long run. For the aggregate HWB model, indicators should reflect changes in the contribution to HWB from both types of activities (*Drivers* and *Impacts*). Focusing only on the latter will produce a biased measure of aggregate HWB changes due to policy actions.

2.3 Human Well-Being Indicators for the Puget Sound Partnership

The choice of HWB indicators for the PSP is complicated by the implicit value judgments involved. The NHDG present an approach to selecting potential HWB indicators given this constraint. Their approach consisted of developing a set of HWB attributes (categories and subcategories) and then searching for indicators associated with each attribute. From this set of “raw” indicators, they then applied the criteria used by the Indicators Technical Working Group (and discussed in O'Neill *et al.*, 2008) to assign each indicator to its appropriate category.

Based on discussions within the HWB Indicators Technical Working Group, one of six technical working groups established under the direction of the PSP and NOAA to identify a suite of preliminary indicators for each PSP focus area, a set of HWB attributes, expressed as categories and sub-categories, were developed. This set spanned all elements of HWB, not just those that might be the direct objects of PSP management. Some of the categories focus on special groups or activities, however, in recognition that these groups and activities may be the object of PSP management. This complete list can be found in Human Well Being Indicators, Morgan Schneider and Mark Plummer, NW Fisheries Science Center (2008).

Criteria listed in O'Neill *et al.* (2008) were used to categorize this suite of HWB indicators. The criteria are expressed as a series of five questions:

1. Is the indicator conceptually valid and relevant to PSP goals?
2. Do data exist for the indicator?
3. Can the indicator be feasibly implemented?
4. Are the statistical properties of the indicator understood?
5. Does the indicator meet management and reporting needs?

In addition, the indicators were categorized by the four HWB outcomes described in Sound Health, Sound Future (2006) and PSP management objectives, management effects, and exogenous human and natural drivers. Possible indicators for the HWB are outlined in a memo from Mark Plummer, NW Fisheries Science Center (2008) to the PSP. These include:

Outcome HWB1: Aesthetic values, opportunities for recreation and access for the enjoyment of Puget Sound are continued and preserved:

1. Puget Sound recreational shellfish harvests
2. Puget Sound recreational finfish harvest
3. Puget Sound recreational activity (non-harvest)
4. Puget Sound publicly accessible or owned shoreline
5. Aesthetic Values related to Puget Sound
6. Sense of place related to Puget Sound

Outcome HWB2: Upland and marine resources are adequate to sustain the treaty rights, as well as the cultural, spiritual, subsistence, ceremonial, medicinal needs and economic endeavors of the tribal communities of Puget Sound.

1. Puget Sound Commercial Indian finfish and shellfish harvest

Outcome HWB3: The Puget Sound ecosystem supports thriving natural resource and marine industry uses such as agriculture, fisheries, forestry, and tourism.

1. Puget sound commercial finfish and shellfish harvest, wild and aquaculture
2. Scenic and sightseeing water transportation
3. Number of Marinas
4. Puget Sound timber harvest
5. Puget Sound land in farms

Outcome HWB4: The Puget Sound's economic prosperity is supported by and compatible with the protection and restoration of the ecosystem.

1. Total population
2. Developable land

2.4 Conclusions

The conceptual models outlined above illustrate graphically the tradeoffs that may arise between different aspects of HWB and point out the linkages between the natural environment and HWB and potential tradeoffs that may arise between HWB and ecosystem restoration actions. To incorporate HWB in efforts to achieve Puget Sound recovery,

resource management framework is needed that will help identify and resolve potential tradeoffs between and among varying value sets and with the natural environment such that HWB is sustained by a functioning Puget Sound ecosystem. The nature of these tradeoffs will undoubtedly change over time suggesting that the conceptual models developed to date will also change. In addition, an adaptive management strategy will assist in refining indicators, while adaptive management tends to focus more on management of the natural environment, Puget Sound managers will need to include HWB within the adaptive management framework.

3.1. Introduction

In attempting to address human well being (HWB) and ecosystem health, Puget Sound Partnership is embarking on largely uncharted territory. Ecosystem management initiatives have not generally addressed HWB for several reasons: there are institutional challenges from existing governmental and social structures, there are few modeling tools to integrate human behavior into predictions of ecosystem health, and many relevant social and economic studies of HWB are lacking. Preceding chapters of this paper address the research and analysis related challenges associated with managing for HWB. The purpose of this chapter is to summarize primary HWB themes which emerged from the Action Agenda Topic Forum Papers, as well as from the Action Area public outreach process, to inform the resource management tactics and strategies which will guide implementation of the Puget Sound Action Agenda.

3.2 Action Agenda Topic Forum HWB Findings

During spring 2008, the Partnership convened groups of experts to assess the state of scientific knowledge, policy, practice, and to provide recommendations pertaining to legislatively defined ecosystem health goals used to guide development of the Puget Sound Action Agenda. Groups of experts were convened within the following topical areas: Habitat-Land Use, Species Biodiversity, Water Quantity, Water Quality, Quality of Life, and Human Health. This tremendous body of information and recommendations provides an excellent foundation from which to develop an adaptive management approach to managing for human well being and ecosystem health. Five papers were produced during the summer of 2008.

Many HWB-related themes emerged from the Action Agenda Topic Forum findings and recommendations. A predominant issue identified by all groups was the issue of tradeoffs and unintended consequences from recovery actions that may affect sectors of the Puget Sound economy, ecological health, and HWB. Some actions to improve Puget Sound ecosystem health may provide benefits to some individuals, groups or ecosystem components while simultaneously negatively impacting others.

One example of tradeoffs identified within the Habitat and Land Use topic forum papers is the decision to construct and maintain regional flood protection facilities, such as levees, along major rivers for the purpose of reducing flood risks to transportation corridors, regional economic centers, and other development within the region's major river floodplains. The resulting disconnection of a river from its floodplain at times produces flood protection benefits the regional economy yet almost always produces costly tradeoffs: a diminished capacity of floodplain wetlands and riparian buffers to serve as natural and dynamic flood protection infrastructure; lower quality and quantity of aquatic habitat needed to support federally listed salmonid species; diminished visual and aesthetic qualities associated with the river; and ongoing capital costs to society for maintenance of flood protection facilities.

A second related HWB theme across topic forum papers was that Puget Sound ecosystem processes were degraded and therefore less capable of supplying vital ecosystem services (e.g., local food, clean water, recreational opportunities, aesthetics, etc.), the basis for a solid economy. Nearly all of the topic forum papers identified land cover change, from vegetated to impervious surfaces, as a primary threat to ecosystem processes and related effects upon provision of ecosystem services. The Species and Biodiversity topic forum paper identified that forestry practices over time have resulted in increases in surface water runoff and altered groundwater recharge rates, fragmented habitat networks for a wide variety of wildlife species, reduction in evapotranspiration rates, increased sediment delivery to streams with resulting water quality implications, as well as marginalized recreational opportunities. Forest resource management practices in the upland portions of Puget Sound watersheds translate to a reduction in ecosystem services that affects the entire region.

The Topic Forum papers also identified the current institutional challenges associated with managing for ecosystem health and HWB, specifically, in conjunction with managing for the projected population growth to our region. Each of the papers stated that the current approach to environment decision-making and management within Puget Sound is decentralized, fragmented, and rarely reflects a coordinated and efficient set of tactics. Many of the Topic Forum papers supported improved coordination between local, state, and federal governments, the business community, community groups, and other stakeholder interests as part of an adaptive management approach to implementing the Action Agenda. One Topic Forum group, Habitat-Land Use, was particularly concerned about the region's ability to effectively manage for HWB and ecosystem health given existing institutional issues and population growth projections. This topic forum went a step further than the other topic forum groups and provided an urgent call for the region to discuss its vision for a future quality of life in the face of forthcoming population growth, stating:

The PSP discussion should include the concepts of the maximum capacity of the region to accommodate increased population from a quality of life standpoint, and from the viewpoint of the resiliency of the ecosystem to sustain stressors over time”.⁵

Additional HWB-ecosystem health themes emerged from the Topic Forum Papers as presented below. Please note that these themes are not presented in priority order and were generated during an informal work session with the topic forum leads:

- Loss of connection between rivers and floodplains, including wetlands, results in increased flood risks
- Loss of habitat leads to loss in scenic value, marginalized recreational opportunities, impacts to aesthetics, impacts to cultural resources, and ecosystem degradation
- Over-regulation leads to loss of food production
- Regulation on behalf of the public good leads to loss of individual choice
- Lack of public awareness regarding the relationships between ecosystem services and societal health HWB
- Human activity disrupts species and their habitats (e.g., development, wildlife viewing, boating, etc.)
- Development patterns and land cover change has resulted in habitat loss, fragmentation, water quality impacts, and impacts to scenic resources
- Aquaculture provides food, supports industry, and recreational opportunities
- Aquaculture can impact aesthetics, recreational opportunities, and physical access to water
- Toxins in biota reduces food availability
- Poor water quality reduces quantity and quality of water-based, recreational opportunities
- Poor water quality impacts aesthetics (odors and reduced visual quality)
- Poor water quality impacts to cultural resources
- Social equity—some groups are disproportionately affected by poor water quality
- Peak stormwater flows reduce recharge resulting in low base flows and associated basin closures, with no additional appropriations
- Over population can lead to loss of water supply, land cover change, and other pressures to ecosystem health

3.3 Puget Sound Sub-regional HWB Themes: Action Area Workshops and Public Outreach

Concurrent with conducting the topic forums the Partnership initiated a comprehensive public process within each of the legislatively defined Puget Sound Action Areas). In an effort to better understand the Sound as a sum of its parts, the Partnership's enabling legislation endorsed use of a sub-regional approach to developing the Action Agenda and identified Action Areas as a means to better understand the unique features, conditions, and threats to ecosystem

⁵ Similar discussions have occurred in other communities that have sought to control growth, including Boulder, Colorado, Petaluma, California and Lake Oswego, Oregon.

health and HWB within each sub-region, and to identify the common issues and interests of the entities in these action areas and for Puget Sound.

While creating the Action Agenda, the Partnership hosted a series of seven workshops, across the Sound, to foster development of a local perspective of the threats to Puget Sound health, helping the Partnership answer the question, “What is the current status of Puget Sound’s health and what are the biggest threats to it?” These workshops also informed the Partnership’s developing priorities for the Action Agenda. Following the winter workshops, Action Area input was sought over many months to develop a customized Action Area Profile for each sub-region. The profiles provide a summary of the physical, ecological, socio-demographic, and other attributes unique to each Action Area and are incorporated into the Action Agenda.

The Action Area workshops and sub-regional public outreach processes produced HWB themes common to all sections portions of the Sound:

- the desire for sustainable commercial and recreational crab, fish, and shellfish harvest
- a deep appreciation for the region’s scenic landscape and quality of life
- acknowledgement of the trade-offs between economic gains from land cover conversion, development and corresponding loss of habitat values
- concerns regarding the implications to HWB and ecosystem health from the effects of projected regional population growth
- a desire for increased access to shoreline environments

An important outcome from developing narrative and graphic profiles for each Action Area was a more complete understanding of each Action Area’s distinctive landscape and associated set of ecosystem health, socio-economic, institutional, and related HWB issues. In addition, the opportunity for local stakeholders to communicate priority Action Area-specific values directly to regional leaders reinforced the importance of information gathering and understanding issues across all scales.

The topic forum papers and the Action Area profiles will help shape the strategies needed to improve HWB and ecosystem health in Puget Sound. Though this body of theoretical and geographic information provides a solid foundation from which to develop the Action Agenda, there are significant remaining research needs. Implementation strategies will clearly require an ongoing commitment to produce information that informs decision makers and supports tracking progress at multiple scales, timelines, and across economic, social science, and ecological disciplines. The remainder of this chapter presents specific management approaches and case studies that profile how resource management actions may account for HWB and ecological health.

3.4 Puget Sound Resource Ecosystem Management Approaches

As the region’s population continues to grow and pressures on the natural environment become more pronounced, it is increasingly important that we improve our understanding of the many ways in which humans in the Puget Sound region benefit from healthy ecosystems, as well as the many ways in which societal actions can directly and indirectly impair or enhance ecosystem health. Implementation of the 2020 Puget Sound Action Agenda provides a unique opportunity to develop standardized approaches to managing for complex human and ecosystem threat/driver relationships; this evolving knowledge base may nurture consistency in management responses and ongoing refinement of ecosystem recovery priorities.

The Action Agenda’s Habitat-Land Use Topic Forum Paper did not comprehensively address the Human Well Being dimensions of ecosystem management approaches, in part because of gaps in knowledge and practice. The Habitat-Land Use Topic Forum Paper did identify a diverse set of ecosystem management strategies and tactics applicable to the Puget Sound region, a subset of which includes: property acquisition and creation of reserves,

regulations, education and incentive programs, capital restoration projects, and best management practices. These tools are applied at multiple scales, from individual property to sub-regional to regional and are variably implemented throughout the watershed, as informed by local and regional priorities. Puget Sound resource managers are also diverse and range from private residential property owners, businesses, non-governmental organizations, local governments, state agencies, tribes, and community stewardship groups. In spite of these efforts, there has been continued degradation over time to Puget Sound ecosystems and attempts to restore past impacts and mitigate for ongoing impacts have been unsuccessful at fully replacing the affected habitats or functions (NRC 1992; NRC 2001). Please see the Action Agenda Land Use-Habitat Topic Forum Paper chapter entitled “Science Question 2 (S2): What do we know about the effectiveness and certainty of protection and restoration approaches aimed at addressing threats to habitat?” for additional detail regarding the known effectiveness of resource management approaches within Puget Sound.

Many Puget Sound approaches to environmental protection fall into one of two broad categories: (1) regulations and legislative mandates, and (2) incentives. The remainder of this chapter summarizes each resource management category, as it applies to HWB.

3.4.1 Regulations and Legislative Mandates

Since the early 1970's, environmental regulations in the United States have traditionally relied on command and control tactics in which regulators, typically the government, sets limits and applies them uniformly to a broad category of sources. With this type of resource management approach, uniform standards are established, consistent processes are employed throughout a system, and conditions are monitored for compliance.

Examples of governmental regulations and legislative mandates include the Clean Air Act, the Clean Water Act, and in Washington State the Growth Management Act (GMA). In the Puget Sound region, regulatory approaches have achieved a mixed set of outcomes; some regulatory tools have successfully achieved their objectives while others have not. For example, there is general consensus that the GMA is achieving its stated goal of generally slowing sprawl and focusing growth in urban areas. Studies generated within King, Pierce, Snohomish, Clark, Kitsap, and Thurston counties reveal that growth has increased within urban areas from 77% to 88% between 1995 and 2007 (CTED 2007). However, the effects of directing growth, to defined urban growth areas, upon ecosystem service provisioning and health has yet to be evaluated.

A comprehensive listing of environment regulations associated with Puget Sound is included as an Appendix P1-1 of the Habitat Land Use Topic Forum Paper. Some considerations associated with command and control regulatory practices include:

- May impose a relatively higher cost of doing business than under alternative management approaches with relatively no change in achieving an improvement in the environment (Environmental Literacy Council, 2008).
- Associated monitoring and enforcement is becoming increasingly expensive, as command and control approaches were initially developed to manage point-source pollutants and current approaches typically require monitoring and measurement of non-point pollutant sources (e.g., stormwater).
- Polluters may have little choice about how to meet the standards and the incentive to research new ways to reduce their emissions may be minimized.
- This approach often generates inflexible institutional arrangements that are not responsive to diverse ecological regions and communities within which they are situated. While expert knowledge can be a great asset in the design and implementation of local resource systems, simply imposing a uniform set of standards and ignoring local ecological and social knowledge does not produce the variety needed to learn from experience (Ostrom, 2008).
- Regulatory approaches can impact the quality of life by reducing the sense of community and social cohesion.

3.4.2 Incentive-Based Policies and Programs

Economic incentives are beginning to play a larger role in achieving environmental protection and restoration goals. These policies and programs encourage an individual or firm to take into account the full set of costs associated with their action (i.e., the negative impacts on the environment) and find innovative, low-cost ways to reduce their negative environmental effects by offering them rewards, or by doling out punishments in the form of taxes or fees, marketable permits, or liability (Austin, 1999).

Economic incentives have the potential to meet increasingly costly environmental quality goals, with more flexibility, and at lower costs. Through participation in incentive based programs, individuals or firms are engaged in finding solutions and the potential exists to contribute to the HWB attributes of social cohesion, environmental stewardship, sense of place, and lower cost of doing business. Additional considerations associated with economic incentive-based policies and programs:

- May have high transaction costs, including verification and monitoring, which often lead to inactive markets.
- Can strengthen HWB attributes of social cohesion, environmental stewardship, respect for various cultures and an ability to 'build and sustain action'. (Environmental Literacy Council, 2008)
- The success of individual incentive programs may be difficult to replicate because success and failure are often a function of the people involved at any given point in time.

Appendix P1-2 of the Habitat and Land Use Topic Forum Paper provides a comprehensive list of incentive programs. A brief discussion of various types of economic incentive-based policies is discussed below (taken from the U.S. EPA, 2001):

Fees, charges and taxes, are one of the most popular forms of economic incentives. Examples are the fees charged for discharging effluent in Washington State. A common concern with fees, charges and taxes is that they are set below the cost of the incremental damage that the pollution is causing or are not set at a rate to achieve the environmental goal. However, in some cases a fee set to achieve either 1) the environmental goal or 2) equivalent incremental damage cost could create concerns about businesses ability to compete and threaten jobs.

Deposit-Refund systems, require a monetary deposit at the time of sale of a product. The deposit is returned when the item is returned. These systems are appropriate for discrete, solid commodities such as beverage containers, lead-acid batteries, tires, etc.—items that would cause environmental harm if improperly disposed of. Costs of implementing a system, with collection and return, can be expensive.

Marketable permits both the 'cap-and-trade' and credit systems have been tried in various locations with various resources. Under cap-and-trade a ceiling is placed on future emissions, then allowances for future emissions are sold or granted to existing sources, and trading of the allowances occurs. Examples include tradable credits for stormwater (Thurston, et al., 2008) and trading programs like wetland mitigation credits. Uncapped credit systems do not establish a ceiling on emissions; rather credits are earned for controlling pollution beyond a baseline specified by a permit. Drawbacks for these mechanisms can include high transaction costs, including verification and monitoring, which often led to inactive markets. Advantages can include incentives for technological innovation.

Subsidies such as grants, low-interest loans, favorable tax treatment and preferential procurement policies for products or permitting for green products/buildings, respectively. Subsidies are used to support private sector pollution prevention and control activities. Subsidies for environmental management are sometimes criticized because the government entity providing the subsidy and the taxpayer ultimately help to bear the costs that could be argued to be the cost of the polluter.

Liability, such as supported by the Clean Water Act, the Superfund Act and the Oil Pollution Act, create a disincentive to pollute. Individuals or firms may attempt to avoid polluting since if found liable they can face large and unpredictable damage claims. While liability has prodded sources to take significant action to reduce pollution, such as managing hazardous waste on site, it is difficult to establish a link between concerns over liability and reductions in pollution.

Information Disclosure, has proven to be an incentive for sources of pollution to reduce their loads. Two laws mandating the public to disclose environmental information are the Toxics Release Inventory (TRI) provisions of the federal Community Right-to-Know Act and California's Proposition 65. The TRI requires only the reporting of information; actions taken by sources to reduce pollution are voluntary so the costs are not known, though speculated to be low.

Voluntary actions are likely the most difficult of the economic incentive-based mechanisms to describe. They can take many forms, involving many stakeholder groups—some grass roots citizen based and others in collaborative arrangements between government entities (e.g., Memorandum of Understandings, Joint Powers Authorities, etc.). The voluntary nature of the actions implies that all the participants are somehow made better off—the quality of life improves. Either there is an economic benefit, and/or an improvement in societal relations, and/or cultural and spiritual values are honored. Also, voluntary actions have the benefit of providing a forum to include local ecological and social knowledge needed to learn from experience—where imposing a uniform set of standards does not (Ostrom, 2008). Learning from experience will promote the Partnership's ability to "build and sustain action." Another common theme with many voluntary actions is that there is collaboration around multi-objective/multi-benefit projects. Collaboration leads to cost sharing which is increasingly necessary as environmental restoration projects become increasingly expensive. Cost sharing allows one entity to participate in a project that may be financially infeasible for them alone, but economically may make sense.

3.5 Conclusion

Given the complex nature of tradeoffs inherent to any resource allocation and management process, implementation of the 2020 Action Agenda necessitates the development of tools and approaches which provide structured approaches to cataloguing information, decision-making, and adaptive management over time. The best professional judgment of the Topic Forum groups, as well as the extensive public process undertaken as part of Action Agenda development, revealed an urgent need for integrative, trans-disciplinary approaches to environmental protection and ecosystem management in support of Puget Sound recovery. This will require a comprehensive approach to information gathering, evaluation, and management over time, to improve the likelihood that multiple stakeholders at all local, regional levels are adequately represented in decision-making processes. Managing for economic, social, and ecological health of Puget Sound is a complex challenge, as few comprehensive, regional-scale adaptive management and monitoring programs within Puget Sound exist. This presents the Partnership with an opportunity to build upon existing environmental protection and resource management tools while also developing innovative approaches and strategies.

4.1. Action Agenda Finance Strategy

The scale of the Action Agenda will require finding new sources to support cleanup and recovery. During the past year, the Partnership has taken several steps to address the complex issue of funding long-term restoration and protection of Puget Sound. This work has included evaluating existing spending on conservation and recovery, identifying strategies to raise additional funding from conventional and innovative sources, securing additional state and federal funding for the near term, and for the first time, evaluating and aligning state agency budgets with Action Agenda priorities.

Implementation of the Action Agenda must reflect a clear understanding of the efficiency and social welfare of different ecosystem recovery and restoration strategies. Cost assessment and benefit/cost analysis will assist in informing levels of economic efficiency of projects. Net economic benefit analysis will also to some extent assist in identifying stakeholder groups whose HWB may be either negatively or positively affected by a particular action. Identification of those affected is critical to management and policy decision makers. While the PSP intends to try and find solutions/strategies that will result in a win/win situation there will necessarily be some circumstances in which one stakeholder group will benefit at the expense of another. Tradeoffs will have to be made between environmental conservation, preservation, recovery, monitoring baseline science and the provision of all other goods and services and institutions which affect HWB (e.g., trading restoration of orca populations for enhanced affordable housing or improved port infrastructure).

Although significant expenditures have been made toward the protection and clean up of Puget Sound, implementation of the Action Agenda will require finding ways to spend existing dollars more effectively as well as raise new sources of funding. Many current sources are not aligned with Action Agenda priorities. Spending decisions on Puget Sound have been based upon the decisions of individual agencies and governments without the guidance of ecosystem priorities or a long-term investment strategy for the Sound. Existing grant and loan programs for infrastructure and capital improvement receive requests for funding that are substantially greater than the amount available. To address some of these funding issues, the Action Agenda provided three overarching funding strategies (for additional detail, see December 1, 2008 Action Agenda, Question 3):

1. Focus existing Puget Sound spending on Action Agenda priorities to increase efficiency
2. Provide additional funding to increase our ability to address priority prevention, restoration, and cleanup needs
3. Use innovative funding methods, including market-based approaches, to increase diversity of funding mechanisms and to engage private sector interests

4.2 Alternative Funding Analysis

The Action Agenda finance strategy also includes recommendations on how to spend existing and raise new federal, state, and local government funding, how to allocate funding, and who should be responsible for execution of the strategy. The plan will identify the total funding and distribution of funding that appears to be needed to accomplish the cleanup and restoration program, as well as the actions needed to achieve the proposed level and distribution of funds. This strategy will also identify the actions needed to establish access funding sources and fine-tune recommendations on allocation and funding responsibilities. It will include objectives for the 2011-13 and 2013-2015 biennia, as well as the future steps needed to accomplish the 2020 strategy.

There are direct and indirect human dimensions to every ecosystem health⁶ issue, yet ecosystem management frameworks often fail to characterize and manage for the human dimensions of ecosystem health. However challenging a task, ecosystem recovery strategies and actions must reflect what can be understood about the complex set of social, economic, and ecosystem interactions. Explicitly managing for human well being, within the context of Puget Sound ecosystem health, will engage broad sectors of the region, making implementation of the PSP Action Agenda possible while hopefully achieving some win-win outcomes.

As a first step it is critical to identify and agree on in the adaptive management process the expected “end states” or goals for ecological, social and economic “health” and or “well being.” Doing so allows us to use conceptual models to effectively articulate the impacts of certain driving forces on various ecosystem states, identify potential conflicts or tradeoffs, and propose responses that will result in the greatest benefit to both people and their surrounding ecosystems as we move through the adaptive management process. These models must take into account the external drivers and be capable of showing the balance and tradeoffs between the expanding share of goods and services in the ecosystem being taken up by humans that are subsidized by connections and exchanges outside the ecosystem, and how these connections influence and afford our current collective vision of HWB (Jacques White, 2008 personal communication). Hopefully, well constructed and inclusive models will both force and support an open discussion of what we think is important to our well being and result in well crafted and realistic goals as we move forward with Puget Sound recovery.

It is clear that there are significant gaps in our understanding of how to incorporate attributes of HWB in conceptual model development and ecosystem management. As such the PSP is forging new ground. The various activities that have been on-going in the development of the Action Agenda lead us to a synthesis of these gaps and recognition of those studies and or assessments that may improve further prioritization and decision making. In the short term the PSP may wish to:

- Continue to establish a meaningful and effective set of measurable HWB indicators. Refine HWB measures as part of the overall indicators of ecosystem health
- Continue to develop conceptual models of how human well being plays a role in ecosystem management as indicated above.
- Continue to develop the integration of the current WRI/TNC/NOAA ecosystem services assessment with the assessments done through the topic forum and indicators work.
- As Finance Strategies are refined, consider that “affordability” of actions must be evaluated at the sub-basin scale and that ecosystem losses due to degradation of habitat and water must be balanced against all possible management strategies including regulatory protection, acquisition and other private agreements, and restoration or mitigation of lost services.
- Evaluate how HWB is and has been incorporated into successful ecosystem management solutions here and in other parts of the country and the world, and identify examples of how attributes of HWB can be woven into future iterations of the PSP Action Agenda.
- Complete a comprehensive review of the types of resource management approaches to identify those most effective in modifying human behavior under varying ecological, social and economic conditions.
- Quantifying, where possible, or at least qualify the potential impact of various resource management approaches on the Puget Sound economy.
- Quantify where possible or qualify the impact of various resource management approaches on other aspects of the HWB—besides the economy—such as sense of place and community, cultural identity, respect for other cultures and good social relations.

⁶ Please note that the term “ecosystem health” is a human construct referring to an undisturbed condition or parts and processes of an ecosystem.

In the long term the PSP may wish to consider and adopt in the Strategic Science Plan:

- Conduct an institutional analysis of all state and local agencies engaged in environmental management with a focus on activities that invest in the enhancement of Puget Sound and its biota. Included in this review shall be the identification of trade-offs, synergies, and evaluation of institutional alignment. Ideas for design and implementation of a such an analysis can be drawn from the Washington Biodiversity Council's "Towards a Biodiversity Conservation Strategy: Institutional Assessment Report," 2006 www.biodiversity.wa.gov; the Evans School work on collaborative governments (Craig Thomas, The Evans School, University of Washington); and People for Puget Sound Memo to the Puget Sound Partnership (May 6, 2008) "Institutional Barriers to Implementation of Puget Sound Plans and Programs."
- Support and or coordinate with a set of demonstration futures analysis such as was conducted in Willamette River Basin and Kitsap County and in the planning stages for Skagit County (John Lombard, AMEC Earth and Environment)
- Develop a better understanding of the linkages between Puget Sound ecosystem services and HWB. Questions that need to be addressed include:
 1. How do specific changes in Puget Sound health affect specific quality of life attributes? (e.g., how do water quality changes such as increased turbidity, nutrient enrichment, algal blooms, toxins/pathogens, or pollutants from stormwater runoff affect economic, social, health, and/or cultural attributes of HWB)
 2. Do these effects differ (and if so how) across geographic areas of the Sound, population sectors, or business/economic sectors?
 3. How do the ecological scales of ecosystem services in the Sound differ from (or match) the governance, management, or regulatory jurisdictional divisions of the Sound?
 4. Who uses and produces ecosystem services? What are the ecological and social scales of ecosystem services? (i.e., at what scales are benefits provided? At what scales is management most effective?)

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Glossary of Terms

Action Agenda Topic Forum: The Puget Sound Partnership convened forums of experts to help synthesize the region's science and policy understanding and knowledge concerning the Partnership goals, as well as identifying strategies to help achieve a healthy Puget Sound. Groups of experts met during Spring 2008 and addressed Water Quality, Water Quantity, Species Biodiversity, Habitat-Land Use, Quality of Life, and Human Health.

Action Area: Puget Sound Partnership's Leadership Council set initial boundaries for seven sub-regions of Puget Sound, called Action Areas: Hood Canal; North Central Puget Sound; San Juan/Whatcom; South Central Puget Sound; South Puget Sound; Strait of Juan de Fuca; and Whidbey.

Ecosystem Services: The variety of benefits that ecosystems provide to people, businesses and communities. Ecosystem services are also some times referred to as environmental services; the terms natural capital or green infrastructure are also some times used to refer to the benefits people realize from the natural world or the contribution of the environment to human well-being.

Ecosystem Management: An approach to natural resource management which aims to sustain ecosystems to meet both ecological and human needs into the future.

Exogenous: A variable outside a described system. For example, climate change may be a variable not included in standard fishery resource allocation.

Existence Value: Is a term used regularly in economic theory and application. It refers to the value an individual may hold for an ecosystem service such as orca whale watching even if they never intend to view orca whales. Existence value is sometimes referred to as a type of nonuse value and is related to bequest and option value.

Sense of Place: The meaning attached to a particular setting by a person or group of people. The characteristics of a physical landscape, and the responses generated by the landscape, are integral to the heart of sense of place.